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RURAL TOURISM AND FOREST FIRES IN PORTUGAL: PATHWAYS TO RESILIENCE IN BURNED LANDSCAPES

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Abstract:

Portugal's interior regions face a critical intersection of challenges: escalating forest fire frequency and rural depopulation. This study examines the intricate relationship between rural tourism development and forest fire occurrence in Portugal's fire-prone territories, addressing a significant research gap in understanding how tourism facilities respond to and recover from wildfire impacts. Using geospatial analysis and temporal data integration, we analysed 989 rural accommodation units established between 1983 and 2025, examining their spatial distribution relative to protected areas and historical burn perimeters from 2000 to 2024. Our findings reveal that 68% of accommodation units are located within or near protected areas, demonstrating tourism's spatial dependence on high ecological value territories. However, this proximity also exposes establishments to significant wildfire risk; 68 units experienced at least one fire event over the study period. Despite these vulnerabilities, the analysis reveals remarkable sectoral resilience. Following major wildfire events in 2003, 2005, and 2017, substantial accommodation development occurred in previously burned areas, indicating economic recovery capacity and renewed investment despite risks. These patterns suggest that rural tourism, when integrated with appropriate fire management and landscape conservation strategies, can catalyse territorial resilience and long-term landscape recovery. Furthermore, agritourism models linking native livestock grazing to tourism activities directly incentivise fire prevention and biomass management. Our findings underscore the potential of tourism-driven economic development to support sustainable land management, highlighting the critical need for integrated policies harmonising tourism expansion with robust fire prevention measures to ensure ecological integrity and community viability in rural Portugal.

Keywords: Rural tourism, forest fires, landscape resilience, spatial analysis, sustainable land management.

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TURISMO RURAL E INCÊNDIOS FLORESTAIS EM PORTUGAL: ESTRATÉGIAS DE RESILIÊNCIA EM TERRITÓRIOS FLAGELADOS PELO FOGO.

Resumo:

As regiões interiores de Portugal enfrentam desafios críticos: o aumento da frequência de incêndios florestais e a desertificação rural. Este estudo analisa a relação entre o desenvolvimento do turismo rural e a ocorrência de incêndios em territórios propensos ao fogo, abordando a lacuna existente sobre como as unidades turísticas respondem e recuperam dos impactos destes eventos. Foram analisadas 989 unidades de alojamento rural estabelecidas entre 1983 e 2025, considerando a sua distribuição espacial em relação a áreas protegidas e perímetros históricos de incêndios entre 2000 e 2024, através de análise geoespacial e integração temporal de dados. Os resultados indicam que 68% das unidades se localizam dentro ou perto de áreas protegidas, revelando a dependência do turismo em territórios de alto valor ecológico. No entanto, esta proximidade aumenta o risco de incêndio, com 68 unidades afetadas por pelo menos um evento durante o período estudado. Apesar destas vulnerabilidades, o setor mostra resiliência significativa: após os grandes incêndios de 2003, 2005 e 2017, registou-se desenvolvimento de alojamentos em áreas previamente queimadas, evidenciando capacidade de recuperação económica e renovação de investimentos. Estes padrões sugerem que o turismo rural, quando associado a estratégias adequadas de gestão do fogo e conservação da paisagem, pode reforçar a resiliência territorial e apoiar a recuperação a longo prazo. Modelos de agroturismo que integram o pastoreio de gado autóctone nas atividades turísticas incentivam a prevenção de incêndios e a gestão de biomassa. Os resultados sublinham o potencial do turismo como motor de desenvolvimento sustentável e a necessidade de políticas que alinhem expansão turística com medidas robustas de prevenção de incêndios, assegurando a integridade ecológica e a viabilidade das comunidades rurais em Portugal.

Palavras-chave: Turismo rural, iIncêndios florestais, resiliência da paisagem, análise espacial, gestão sustentável do território.

1. INTRODUCTION

The escalating prevalence of wildfires in Mediterranean regions, particularly Portugal, poses a critical threat to its vital tourism sector, necessitating innovative approaches to territorial planning that integrate fiscal policies and cooperative management (Abrhám et al., 2024; Almeida, 2020; Otrachshenko & Nunes, 2019). While rural tourism can intensify regional vulnerability to fire, it also offers a compelling pathway for revitalising remote, unpopulated areas, fostering long-term resilience, and sustaining landscape management, a dynamic further influenced by digital transformation (Alonso et al., 2024; Rodrigues et al., 2022).

Historically, rural exodus and desertification in Portugal's interior have exacerbated fire risk, yet simultaneously created opportunities for rural tourism to stimulate local economies, generate employment, and preserve natural landscapes, thereby preventing further depopulation (Preinfalk & Handmer, 2024; Santos et al., 2023; Tenreiro &

Martinho, 2024). This symbiotic relationship between economic development and environmental stewardship is crucial, particularly as fire-affected areas near protected zones present unique, albeit challenging, entrepreneurial opportunities for investors seeking to capitalise on cheap property and natural settings (Huang & Skidmore, 2023; Johansson, 2013; Nie et al., 2023). This drive is rooted in the philosophy of sustainable rural tourism, which encourages investments in integrated forest and fire management, fostering a virtuous cycle where economic benefits incentivise responsible land management and contribute to fire prevention (Uyttewaal et al., 2023). Modern tourists increasingly seek authentic natural and cultural experiences, leading to the need to promote attractivity boosts through the reintroduction of traditional practices that bolster community involvement and conservation (Grammalidis & Grammatikopoulou, 2024; Putri & Sayono, 2024; Šušić & Đorđević, 2019). Given that forest fires represent a significant and persistent threat in Portugal (Santos et al., 2022), comprehensive strategies beyond mere suppression are essential, integrating sustainable tourism with robust fire prevention to safeguard ecological integrity and local livelihoods (Ferreira et al., 2024; Silva et al., 2019). Indeed, nature-based tourism can serve as a self-financing mechanism for conservation, enhancing natural and cultural landscapes, and promoting long-term viability through environmental education(Abrhám et al., 2024; Silva et al., 2023) integrated fiscal policies (Andrianambinina et al., 2023), high taxes(Meleddu et al., 2023), and adequate inheritance laws adjusted to the social function of properties to address the structural drivers of landscape abandonment and fire risk (Almeida, 2020). For sustainable rural development, the complementarity between socioeconomic activities is fundamental to create synergies and positive externalities for populations in less favoured spaces (Tenreiro & Martinho, 2024). Such synergies are essential to counteract the structural duality between the coastline and interior, as well as the Portuguese profound inequality, by fostering endogenous development opportunities that encompass sustainable rural tourism, agriculture, forestry, and renewable energy (Silva et al., 2019; Uyttewaal et al., 2023).

To fully appreciate these dynamics and the specific challenges and opportunities presented, it is essential to first establish a foundational understanding of the geographic characteristics of Portugal, particularly its interior regions most susceptible to these interactions. While some perspectives suggest that the growth of nature and rural tourism might inadvertently heighten regional vulnerability to wildfires(Alcasena et al., 2021; Tonini et al., 2018), an alternative viewpoint posits that the strategic occupation and subsequent recovery of remote, often sparsely populated, areas through rural tourism initiatives can paradoxically foster long-term resilience and contribute significantly to sustained landscape management(Álvarez & Vázquez, 2020; Sansilvestri et al., 2022). Moreover, the ongoing digital transformation within rural tourism, particularly in its supply and demand dynamics, is increasingly recognised as a pivotal factor (Rasyid, 2025). This transformation offers novel avenues for understanding how tourism can effectively counteract the detrimental repercussions of climate change-induced hazards and cultivate enhanced resilience within susceptible landscapes (Wilkins & Horne, 2024).

Historically, Portugal's interior regions have been marked by substantial rural exodus and desertification since the mid-20th century, a demographic shift that has inadvertently augmented wildfire risk(OECD, 2023). It is imperative to acknowledge that forest fires in Portugal constitute a significant and persistent threat, accounting for approximately half of the largest fire incidents in Europe over the last decade and resulting in the

destruction of an estimated 90,000 hectares of forest annually (Otrachshenko & Nunes, 2019). These sobering statistics underscore the urgent necessity for comprehensive strategies that extend beyond mere fire suppression, critically embracing proactive land management and sustainable tourism practices as integral components of a long-term solution(Santos et al., 2025; Tülek & ALTUNTAŞ, 2021). The widespread abandonment of traditional land management practices has contributed to a dangerous accumulation of fuel, thereby escalating fire risk. This challenge is further exacerbated by prevailing climate change scenarios, which predict increased temperatures and decreased precipitation across the Mediterranean region (Otrachshenko & Nunes, 2019). Consequently, the seamless integration of sustainable tourism development with robust fire prevention and landscape management strategies is paramount for safeguarding both ecological integrity and the livelihoods of local communities (Lopes et al., 2025; Santos et al., 2022).

This challenging context, however, also presents a unique opportunity for rural tourism to catalyse the revitalisation of these territories (Almeida, 2020; Tenreiro & Martinho, 2024). Such revitalisation promises a cascade of benefits, including the invigoration of local economies, the generation of employment opportunities, and the preservation of natural landscapes, thereby counteracting further depopulation (León et al., 2020). A crucial aspect of this integrated approach is the assurance that the expansion of rural tourism fosters a symbiotic relationship between economic development and environmental stewardship, rather than inadvertently exacerbating fire risks (Iannucci et al., 2022; Tenreiro & Martinho, 2024). Indeed, tourism and leisure are progressively acknowledged as strategic sectors capable of driving economic diversification and revitalisation in rural areas confronting structural difficulties, primarily through the judicious leverage of their inherent natural, landscape, and cultural assets (Ivona, 2021; Novikova et al., 2020).

Intriguingly, the landscapes significantly impacted by forest fires, particularly those situated proximate to protected zones, may concurrently present a distinct, albeit challenging, entrepreneurial frontier. Despite the inherent devastation and associated risks, these areas can offer opportunities for acquiring property at lower valuations within unique natural settings (Demirdağ & Nirwansyah, 2024). This dynamic can attract tourism entrepreneurs keen on investing and capitalising on such conditions, thereby contributing to the broader revitalisation efforts within fire-affected regions. This entrepreneurial drive, while often navigating significant challenges, can inject capital and innovation into recovery processes (Correia & Pereira, 2023).

Central to the philosophy of sustainable rural tourism is the cultivation of an appreciative and respectful relationship with nature. This fundamental principle encourages the emergence of endogenous development opportunities and stimulates both private and public investments in integrated forest and fire management practices (Uyttewaal et al., 2023). This approach subsequently engenders a virtuous cycle wherein the economic benefits derived from tourism directly incentivise responsible land management, thus contributing significantly to proactive fire prevention and the overall health of ecosystems (Abrhám et al., 2024). Contemporary tourists, driven by a desire for authentic experiences and deeper connections, are increasingly gravitating towards natural and culturally rich destinations that offer unique ecosystems and genuine local community engagement (Carvache-Franco et al., 2024). In response, developers and local communities are often observed reintroducing traditional practices, carefully sustained

through vigilant management and active community involvement (Breban et al., 2025). This symbiotic relationship between tourism development and conservation holds the transformative potential to reshape rural areas into self-sustaining communities that adeptly harness their cultural heritage and natural assets (Engelhardt, 2008).

Ultimately, nature-based tourism possesses the capacity to function as a self-financing mechanism for protected areas, serving as a powerful instrument for conservation and a catalyst for raising environmental awareness (Liu et al., 2012). Within Portugal, sustainable tourism development is explicitly recognised as a strategic imperative to enhance natural and cultural landscapes and to foster the long-term viability of both natural and human resources (Santos & Castanho, 2024). Further reinforcing these efforts, environmental education initiatives, thoughtfully embedded within tourism experiences, can significantly shape public perceptions and cultivate a deeper appreciation for intact ecosystems, thereby directly supporting broader conservation objectives (Vinodan & Meera, 2024; Wang et al., 2024).

Notwithstanding the substantial debate, a critical research gap persists in fully comprehending the intricate relationship between the escalating growth of rural tourism and the increasing frequency of forest fires within Portugal's interior regions, a phenomenon exacerbated by rural exodus and desertification. To address this, current research analyses these correlations by accessing data from Turismo de Portugal and examining the operational status of rural tourism facilities in areas within, or in the vicinity of, historical burnt perimeters, thereby contributing to both development and landscape conservation (Tenreiro & Martinho, 2024). Spatial analysis techniques, particularly Geographic Information Systems, are proving indispensable in this investigation, overlaying tourism facility locations with historical fire perimeters to identify patterns of resilience and recovery within vulnerable landscapes (Moya, 2015). This methodological approach offers invaluable insights into the adaptive mechanisms of the tourism sector in response to environmental challenges, informing sustainable rural development strategies in fire-prone regions.

The analysis further incorporates socio-economic and geomorphological attributes of municipalities, alongside an examination of Common Agricultural Policy investments in forest management, seeking to elucidate their influence on both fire occurrence and the nuanced distribution of rural tourism establishments (Viegas et al., 2022). This robust and integrated approach is essential to establish reliable correlations and providing a nuanced understanding of their complex interplay in shaping Portugal's evolving rural landscape.

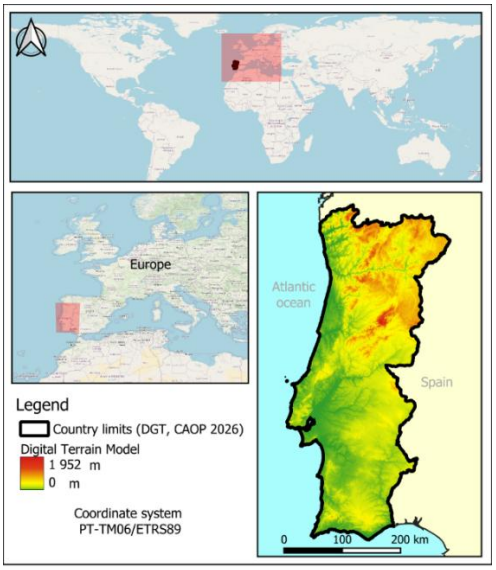
Such an investigation is crucial given Portugal's long-standing environmental conflicts concerning resource extraction versus conservation, which mirror the tensions between economic development through tourism and ecological preservation (Diaz & Santos, 2025). Here, rural tourism and natural protected areas share a symbiotic, yet delicate, relationship; protected areas attract tourism, but also increase anthropogenic pressure on sensitive ecosystems, complicated by regulatory frameworks (Santos et al., 2025). The prevailing focus on pure conservation often overlooks the potential for integrated landscape planning that incorporates human occupation and fire prevention as core components of ecological sustainability (Magalhães et al., 2021). Within this context, rural tourism emerges as both a potential driver of pressure and a crucial ally in building more fire-resilient landscapes.

This investigation is particularly pertinent given the long-standing environmental conflicts in Portugal, specifically those concerning resource extraction versus conservation (Primdahl et al., 2020). These tensions parallel the observed dynamics between economic development through tourism and the imperatives of ecological preservation (Diaz & Santos, 2025). Rural tourism and natural protected areas often share a symbiotic, yet delicate, relationship: protected areas frequently serve as primary attractions driving local economies, but they also inevitably increase anthropogenic pressure on sensitive ecosystems. This intricate balance is further complicated by the vulnerability of these areas to strict regulatory frameworks and conservation policies (Khodzhaeva, 2020). The prevailing focus on purely conservationist strategies often overlooks the significant potential for integrated landscape planning that actively incorporates human occupation and proactive fire prevention as core components of a holistic approach to ecological sustainability (Magalhães et al., 2022). Within this critical context, rural tourism can be understood not only as a potential driver of pressure but also as a crucial ally in the collective effort to build more fire-resilient landscapes.

2. STUDY AREA

Mainland Portugal, the focus of this study, is located in the southwestern Iberian Peninsula, between Spain and the Atlantic Ocean and in relative proximity to North Africa. Covering approximately 89,000 km², the territory exhibits marked geomorphological diversity (Fig.1). Mountainous areas dominate the north, including Serra da Estrela, whose highest point, Torre, reaches 1,993 m. The Tagus River divides the country into two regions of similar size but distinct physical characteristics. The north, generally more rugged and mountainous, the south is characterised by more extensive plains, whereas the central region displays a transitional zone rising from the Tagus river plains to the Montejunto-Estrela mountain range (figure 1).

Figure 1. Geographical location of Portugal with a relief Digital Elevation Layer cover



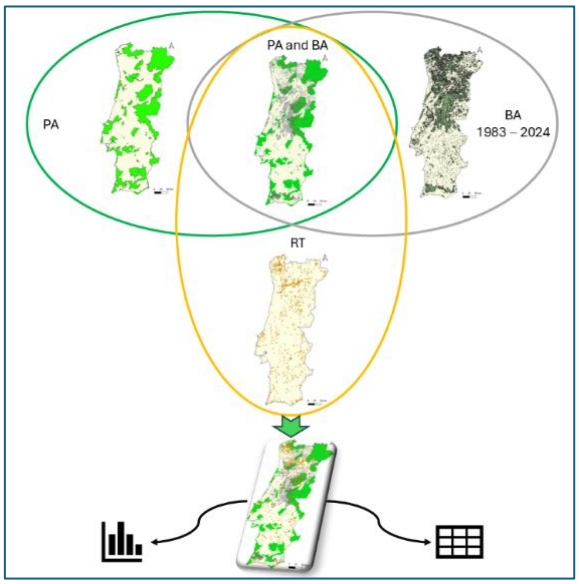
Source:Own composition with basedata from Direção Geral do Território DGT and Open Street Maps.

Portugal has around 10.3 million inhabitants, with a strongly asymmetric population distribution. Most of the population is concentrated in the metropolitan areas of Lisbon and Porto, along the central coastal strip and in the Algarve. By contrast, much of the interior, particularly the North, Centre and Alentejo regions, has very low population densities, often below 20 inhabitants per km². These sparsely populated areas are exactly those most vulnerable to land abandonment, fuel buildup, and recurrent wildfires, which include many protected areas and unique rural landscapes that support the development of nature-based and rural tourism. The combination of demographic decline and fire-prone landscapes, along with significant tourism potential, positions mainland Portugal as an important context for examining the relationship between rural tourism, wildfire risk, and territorial resilience.

3. METHODOLOGY

Building upon the identified research gap and the distinct characteristics of mainland Portugal, this study employs a multi-faceted methodological approach to investigate the complex interplay between rural tourism and wildfire dynamics. The core of this methodology is centered on robust spatial analysis and the integration of diverse datasets.

Figure 2. Methodological approach conceptual model (own composition). Protected Areas (PA); Burnt Areas (BA)



Source: Own composition QGIS.

The methodological framework employed to investigate the intricate relationship between rural tourism development, forest fire occurrences, and landscape resilience focuses on a robust, data-driven analytical approach (figure 2). Our methodology integrates geospatial analysis of burnt areas with temporal data on rural tourism facility establishment and cessation, allowing for a comprehensive assessment of their spatial and temporal correlations. This involved leveraging Geographical Information Systems to integrate diverse datasets, enabling the visualisation and analysis of spatial and non-spatial information related to tourism infrastructure and fire incidence across the landscape (Vogklis, 2025).

The present study used data provided by Turismo de Portugal , containing alphanumeric information on local accommodation in rural areas. For this purpose, key types of Accommodation in Portugal, such as Rural Hotels, Pousadas, Local Accommodation (Alojamento Local), Guest Houses, Country Homes, and Unique/Alternative Stays, such as Glamping sites and huts, were selected. The collected database data was geocoded and converted into geographic coordinates (WGS 84). Data was further integrated into QGIS software and organised in a file initially in CSV format, later converted to SHP format, preserving all relevant attributes supplied by Turismo de Portugal.

Burnt area data from 2000 to 2024, provided by the Institute for Nature Conservation and Forests (ICNF)[3], were incorporated into the project. Only areas larger than 5 hectares were considered, as information for smaller areas is not systematically available for the entire period. The ICNF also supplied maps for the various categories of protected areas in Portugal, including the National Network of Protected Areas, the Natura 2000 Network, Biosphere Reserves, Ramsar Sites, Special Protection Areas, Sites of Community Importance, and geoparks.

Spatial intersections were carried out between the locations of the analysed accommodation types, the burnt areas and the protected areas, to identify accommodation situated in classified territories or affected by wildfires. Additionally, a 5 km buffer zone was applied around the protected areas, assuming that this distance represents a meaningful proximity margin for the tourist experience and, consequently, for tourism attractiveness.

To determine the mean value, equation (1) was used to calculate the temporal trajectory of burnt areas in relation to the emergence of accommodation units, where the temporal delay is Δt, corresponding to the subtraction between B_i (year of accommodation opening) and F_j (year of the wildfire). For this analysis, only $\Delta t \geq 0$ was considered, meaning that only openings occurring after the wildfire were included, as the aim is to analyse the effect of wildfires on investment in rural tourist accommodation. The analysis was divided into two temporal series in order to assess whether the trend was homogeneous or not.

$$\Delta t = B_i - F_j \; com \; \Delta t_{ij} \geq 0 \qquad eq.(1)$$

The mean number of years after the wildfire in which accommodation openings occur is calculated as:

$$\overline{\Delta t} = \frac{\sum_{i=1}^{n} \sum_{j=1}^{m} N_{ij} \cdot \left(B_i - F_j\right)}{\sum_{i=1}^{n} \sum_{j=1}^{m} N_{ij}} \qquad eq.(2)$$

Where: (N_{ij})is the number of accommodation units in cell (i, j); (n) is the number of opening years; (m) is the number of wildfire years

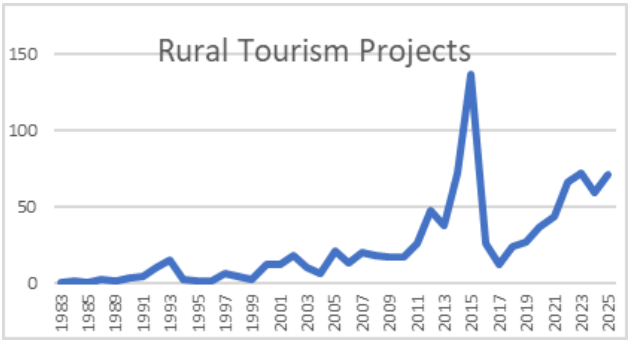
[3] https://www.icnf.pt/florestas/gfr/gfrgestaoinformacao/grfrelatorios/areasardidaseocorrencias

The study adopts an integrated analytical framework that acknowledges the complex interactions between human activities (rural tourism, land abandonment), environmental factors (wildfires, geomorphology), and policy interventions. By establishing robust correlations, this research seeks to move beyond a purely conservationist perspective, integrating human occupation and fire prevention as core components of ecological sustainability within landscape planning. The aim is to understand how rural tourism acts as both a potential driver of pressure and a critical ally in fostering fire-resilient landscapes in Portugal.

4. RESULTS

This approach reveals patterns of rural tourism development in areas with varying fire histories and risk profiles, thereby enabling an assessment of tourism's potential role in landscape recovery and resilience (Magalhães et al., 2022). Of the 1,074 local accommodation units initially identified, 989 were included in the analysis after excluding records without a start operation date. These accommodation units have opening dates ranging from 1983 to 2024 and form a grand total of 17,389 (figure 3).

Figure 3. Evolution of new Tourism facilities since 1983.

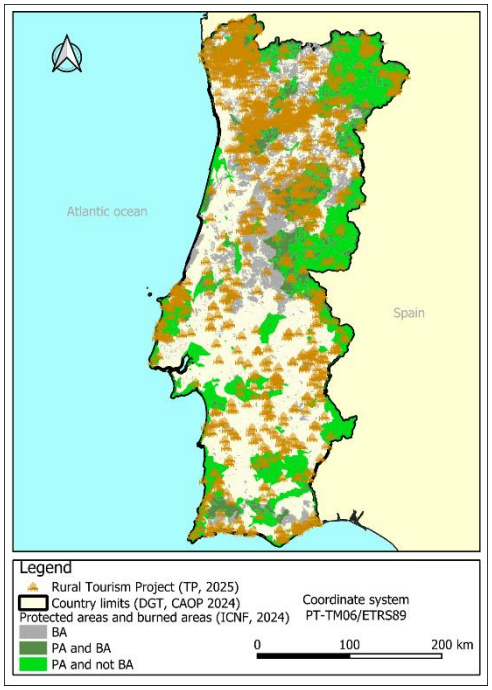


Source: Own composition Microsoft Excel.

The spatial distribution of accommodation units is presented in the map of the figure 4, allowing identification of a strong concentration in classified territories. Of the total accommodation units analysed, 346, corresponding to 35%, are located in protected areas. When a 5 km buffer zone around these areas is considered, the number of accommodation units increases to 669, representing 68% of the total, highlighting a close relationship between rural tourism supply and areas with high ecological and landscape value.

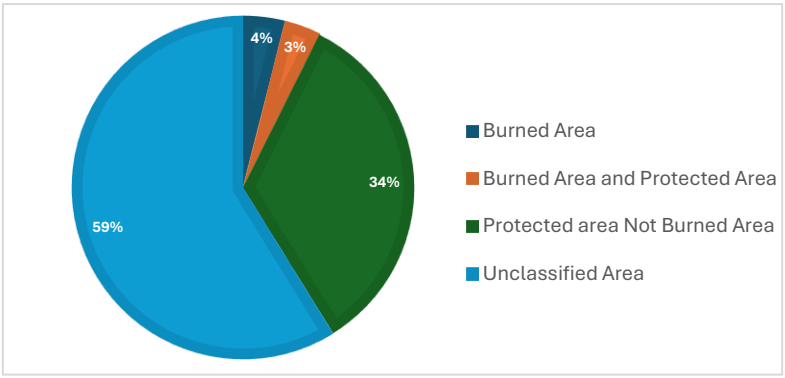
The combined analysis of accommodation location in relation to burnt areas, protected areas and non-classified territory is summarised in the graph presented in Figure 5. The results indicate that 67 accommodation units, representing 7% of the total, are located in areas that experienced wildfires at least once between 2000 and 2024. The cumulative burnt area during this period amounts to 2,172,921 hectares, corresponding to approximately 25% of Portuguese mainland territory, including areas affected by multiple fire events. Additionally, 34% of accommodation units are located in protected areas that were not affected by wildfires during the analysis period, while the remaining 59% are situated in non-classified areas also unaffected by fires. This statistic, illustrated in Figure 4, underscores a strong relationship between the supply of rural tourism and areas of high ecological and landscape value.

Figure 4. Combined overlay map of Natural classified areas(PA), rural accommodation units(Rural Tourism Project) and burnt areas(BA).



Source: Own composition QGIS with basedata from Direção Geral do Território DGT and Open Street Maps.

Figure 5. Pie chart of the combined analysis of accommodation location in relation to burnt areas.



Source:Own composition Microsoft Excel.

The temporal analysis, informed by the equation which calculates the delay between wildfire events and accommodation openings, reveals distinct patterns of resilience and adaptation within the rural tourism sector. The temporal distribution of accommodation units affected by wildfires shows that, while in most years only a single accommodation unit was found in burnt areas, specific periods witnessed a particularly severe impact. Critical years for rural tourism, coinciding with widespread and intense wildfires nationally, include 2003 (9 affected units), 2005 (13 units), 2017 (25 units), and 2024 (4

units). The year 2017 stands out for the magnitude of human, ecological, and economic losses, indicating that areas with significant tourism dynamism were heavily impacted.

Table 1. Matrix of burnt accommodation units per year, considering the opening date.

Tourism Infrastructure Opening Year	Year of Forest Fire Occurence																								
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	Totais
2000																										0
2001																										0
2002																										0
2003																		1								1
2004																										0
2005																		2								2
2006						1					1							1								3
2007																										0
2008																		1								1
2009								1													1				1	3
2010																										0
2011						4												1								5
2012						2												1					1			4
2013				1				1										5								7
2014						1												1							1	3
2015	1	2		1	3	2					1			1		1	1	4						1		18
2016																										0
2017																		1								1
2018													1				1							1		3
2019																										0
2020	1			1		2				1									1	1						7
2021				6																					1	7
2022																	1	2								3
2023			1			1												1								3
2024																		4							1	5
Totals	2	2	1	9	3	13	0	2	0	1	2	0	1	1	0	1	3	25	1	1	1	0	1	2	4	76

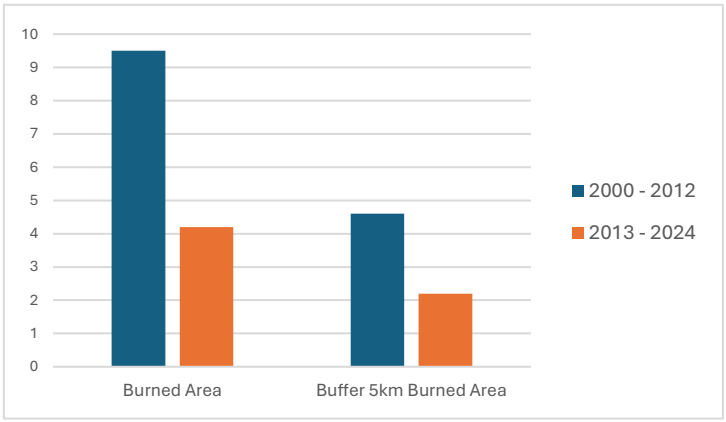
Based on Table 1's matrix and using equations 1&2, described in the methodology, it was possible to calculate the average time required for the emergence of new accommodation following wildfires. This analysis results from crossing the year of wildfire occurrence with the year of accommodation opening, allowing assessment of the temporal lag between fire disturbance and the resumption of tourism activity. The methodology was applied both to accommodation located in directly burnt areas and to those situated within 5 km of such areas. The study period, between 2000 and 2024, was divided into two equal parts in order to identify distinct temporal trends, considering the increase in accommodation numbers in more recent years and the simultaneous evolution of burnt area and the decrease in wildfire occurrence.

The results presented in the graph in Figure 6 reveal clear differences between the two analysed periods. Between 2000 and 2012, the average time for accommodation to commence activity in directly burnt areas is high, at 9.5 years, while in areas located within 5 km the average value is 4.6 years, suggesting greater attractiveness or recovery capacity outside the directly affected zones. In the more recent period, between 2013 and 2024, a marked reduction in these average times is observed, with accommodation beginning activity after 4.2 years in burnt areas and after only 2.2 years in surrounding areas. This evolution points to an acceleration of the post-fire accommodation establishment process, possibly associated with improved recovery conditions, increased tourism investment dynamism or more effective planning and support policies, while maintaining the difference between burnt areas and adjacent zones.

The comparison between area types and temporal periods thus reveals a spatial and temporal redistribution of post-fire tourism development. Directly burnt areas tend to exhibit more delayed reoccupation processes, often associated with strategies of landscape revaluation or functional reinterpretation of the territory, whereas surrounding areas maintain a more continuous and rapid growth dynamic, demonstrating greater

functional resilience. This pattern suggests that wildfires do not necessarily lead to a structural decline in regional tourism, but rather to a reorganisation of investment in space and time, shaped by risk perception, environmental conditions and emerging territorial planning opportunities.

Figure 6. The average time required for the emergence of new accommodation following wildfires in the periods 2000-2012 and 2013-2024, for Protected Areas and 5km buffer.



Source: Own composition Microsoft Excel.

From a civil protection and spatial planning perspective, these results raise relevant concerns, as the increasing concentration of tourist accommodation near burnt areas may heighten future exposure to new wildfires, particularly in a context of climate change and recurring fire events. This reinforces the need to explicitly integrate wildfire risk into tourism planning instruments and licensing processes, promoting development models that reconcile tourism attractiveness, population safety and landscape sustainability. In summary, the results demonstrate that tourism responds differently to wildfires across the territory, with longer recovery times in directly affected areas and faster responses in surrounding zones, contributing to a deeper understanding of post-fire dynamics and providing relevant empirical evidence for the definition of integrated public policies.

The analysis reveals a complex and spatially differentiated relationship between rural tourism development, the presence of protected areas, and the occurrence of wildfires in Portugal. These findings are underpinned by detailed spatial and temporal analyses, including visualizations such as the described graph of accommodation distribution relative to burnt areas and protected territories.

5. DISCUSSION

The findings illuminate a complex and dynamic relationship between rural tourism, protected areas, and wildfire occurrence in mainland Portugal, offering crucial insights for cultural tourism development in vulnerable landscapes. The high concentration of rural accommodation within and around protected areas underscores the intrinsic link between cultural and natural heritage and tourism attractiveness. This geographical convergence, also identified by many authors(Delgado et al., 2020; Guedes & Jiménez,

2015; Jansen-Verbeke, 2009; Joshi et al., 2023; Palermo et al., 2023), while economically beneficial, simultaneously exposes these enterprises to heightened risks, particularly in regions prone to recurrent wildfires, which creates a tension between tourism appeal and environmental vulnerability that must be carefully managed.

The observed resilience of the rural tourism sector in the face of wildfire is a critical finding, particularly for cultural tourism, which often relies on the enduring character of places. Despite immediate negative impacts, the continuous establishment of new accommodation in recently burnt areas suggests that wildfire is not an absolute deterrent to tourism investment. This dynamic can be attributed to several factors, including perceived mid-term economic opportunities, the revaluation of landscapes following natural regeneration, access to public support for rural development, and strengthened territorial recovery policies. Such resilience is particularly pertinent for cultural tourism, where authenticity and landscape narratives can evolve even after ecological disturbances. The reorganisation of investment in space and time, with delayed reoccupation in directly burnt areas and rapid growth in surrounding zones, highlights the sector's adaptive capacity. This implies a cultural reimagining of affected landscapes, where post-fire environments can be re-interpreted for new forms of tourism, such as dark tourism (related to disaster sites) or eco-tourism focused on regeneration and resilience (Reiner et al., 2023).

However, these results also raise significant concerns from a civil protection and spatial planning perspective. Similar to the findings of Otrachsenko & Nunes 2019, the progressive concentration of tourist accommodation near burnt areas, especially in the context of climate change and increasing fire recurrence, could heighten future exposure to new wildfires. This necessitates a more systematic integration of wildfire risk into tourism planning instruments and licensing processes, promoting development models that reconcile tourism attractiveness, population safety, and landscape sustainability. For cultural tourism, this implies a need to develop narratives and experiences that educate visitors about fire ecology, prevention, and the resilience of human-nature interactions in these landscapes, rather than simply avoiding affected areas. Such educational tourism can transform a potential threat into a unique cultural and ecological learning opportunity.

The severity of wildfire impacts in specific years (e.g., 2017) underscores the challenges to sector sustainability and crisis response. Yet the accelerated post-fire recovery observed in recent periods (2013–2024) suggests improvements in territorial planning and risk perception, which are crucial for the long-term viability of rural and cultural tourism. The study's emphasis on integrated public policies that promote nature conservation, wildfire prevention, and sustainable rural tourism development is paramount for strengthening territorial resilience. This includes finding sustainable financial justifications for environmental services, such as grazing animals for vegetation management, which can also become part of an educational tourism experience, showcasing coexistence and active fire prevention. These practices can not only contribute to fire prevention but also enhance the cultural landscape, providing unique experiences for tourists interested in sustainable land management and traditional practices.

Sustainable rural development requires the complementarity between socioeconomic activities to create synergies and positive externalities for populations in less favoured spaces, where the great challenge lies in creating attractive employment to avoid

desertification and its consequences (Tenreiro & Martinho, 2024). In this context, rural tourism emerges as a strategic driver for territorial cohesion, capable of generating economic value while fostering the preservation of environmental and cultural heritage (Turtureanu et al., 2025). This necessitates the implementation of comprehensive planning frameworks that balance economic growth with ecological stewardship, ensuring that the expansion of tourism activities contributes positively to the resilience and vitality of these vulnerable regions.

Ultimately, achieving this balance demands a paradigm shift towards regenerative tourism models that actively restore ecosystems and enhance community well-being, rather than merely mitigating negative impacts (Joshi et al., 2023). This regenerative approach requires the active integration of diverse knowledge systems, from expert and local to traditional experiential knowledge, to catalyse meaningful transformation within socioenvironmental systems ("Kindling Change: Shaping a New Fire Culture in Mediterranean Socioenvironmental Systems from the Roots," 2024). By fostering synergies between economic development and ecological stewardship, such models can ensure that tourism catalyses long-term landscape resilience and community vitality (Joshi et al., 2023). This holistic perspective aligns with emerging calls for regenerative tourism that prioritises the restoration of living systems and the enhancement of landscape services in traditional multifunctional cultural landscapes (Joshi et al., 2023). Effective management strategies are thus crucial for balancing tourism development with the imperative of preserving ecological integrity and cultural authenticity in these sensitive rural environments.

While previous studies have extensively examined the drivers of rural tourism growth and the biophysical factors influencing forest fire regimes independently, there remains a significant dearth of research explicitly linking the operational longevity of rural tourism facilities with post-fire landscape recovery and prevention strategies in areas susceptible to such events. This study addresses that gap by employing spatial analysis techniques to overlay tourism facility locations with historical fire perimeters, thereby identifying patterns of resilience and recovery within these vulnerable landscapes.

The results reveal that while direct fire impacts correlate with temporary declines in accommodation density, the broader tourism infrastructure often exhibits functional resilience, with reinvestment patterns shifting towards less affected peripheral zones. These peripheral zones frequently serve as critical refuges for biodiversity and traditional land-use practices, offering opportunities for integrated territorial planning that aligns tourism development with sustainable forest and fire management objectives (Uyttewaal et al., 2023). Specifically, the economic benefits derived from tourism can be strategically reinvested into supporting traditional grazing systems and other sustainable land management practices, creating a self-perpetuating cycle of ecological and economic resilience.

6. CONCLUSIONS

This study provides robust empirical evidence on the intricate relationship between rural tourist accommodation development, the presence of protected areas, and the occurrence of wildfires in Portugal. The findings confirm that natural and landscape values are decisive factors for tourism attractiveness, leading to a high concentration of accommodation in classified territories and their surroundings. However, this spatial

pattern also reveals an increased exposure to fire-related risks, highlighting a critical challenge for sustainable cultural tourism.

Crucially, the analysis, as derived from the graphical and spatial data, demonstrates that wildfires do not necessarily lead to a structural decline in tourism but rather influence the spatial and temporal dynamics of investment and reorganisation across the territory. Directly burnt areas experience longer reoccupation times, reflecting slower recovery and medium-to-long term territorial revaluation strategies. Conversely, surrounding areas show greater functional resilience and a quicker capacity to attract new accommodation. The accelerated establishment of accommodation in the most recent period, further reinforced by the quantitative analysis of temporal delays, suggests a growing dynamism in rural tourism and potentially improved adaptive strategies in response to wildfire events.

Our findings underscore the potential of tourism-driven economic development to support sustainable land management, emphasising the critical need for integrated policies that harmonise tourism expansion with robust fire prevention measures. This is essential for ensuring ecological integrity and community viability in rural Portugal, particularly as the sector increasingly relies on and interacts with vulnerable cultural and natural landscapes. For cultural tourism, this means recognising and integrating the evolving narratives of resilience and adaptation within fire-affected regions.

Future research should further explore these findings by incorporating indicators of fire severity, vegetation regeneration times, and the socio-economic characteristics of territories. Analysing risk perception among tourism promoters and visitors, as well as the role of planning instruments and public incentives in accommodation location, represents relevant avenues for investigation. Comparative studies across different regions or Mediterranean contexts would also allow for assessing the robustness and generalisation of the identified patterns, further contributing to a deeper understanding of post-fire dynamics and informing integrated public policies that effectively articulate tourism, landscape management, and civil protection in an era of increasing environmental risk. Such an approach is vital for the long-term sustainability and cultural enrichment of Portugal's unique rural landscapes.

REFERENCES

Abrhám, J., Soukupová, J., & Procházka, P. (2024). Wildfires and tourism in the Mediterranean: Balancing conservation and economic interests. BioResources, 20(1), 500. https://doi.org/10.15376/biores.20.1.500-526

Alcasena, F., Ager, A. A., Page, Y. L., Bessa, P., Loureiro, C., & Oliveira, T. (2021). Assessing Wildfire Exposure to Communities and Protected Areas in Portugal. Fire, 4(4), 82. https://doi.org/10.3390/fire4040082

Almeida, M. A. P. de. (2020). The use of rural areas in Portugal: Historical perspective and the new trends. https://doi.org/10.15304/rge.29.2.6750

Alonso, N., Valverde, L. V., & Pozo, D. T. del. (2024). Digitalisation and rural tourism development in Europe. Tourism & Management Studies, 20, 33. https://doi.org/10.18089/tms.2024si03

Álvarez, B. M., & Vázquez, J. A. C. (2020). "May the Smoke Keep Coming Out the Fireplace": Moral Connections between Rural Tourism and Socio-Ecological Resilience in the EUME Region, Galicia. Sustainability, 12(11), 4602. https://doi.org/10.3390/su12114602

Andrianambinina, F. O. D., Schuurman, D., Rakotoarijaona, M. A., Razanajovy, C. N., Ramparany, H. M., Rafanoharana, S., Rasamuel, H. A., Faragher, K. D., Waeber, P. O., & Wilmé, L. (2023). Boost the resilience of protected areas to shocks by reducing their dependency on tourism. PLoS ONE, 18(4). https://doi.org/10.1371/journal.pone.0278591

Breban, M., Bădulescu, D., Bădulescu, A., & Ştiubea, E. (2025). MITIGATING THE NEGATIVE EFFECTS OF CULTURAL AND EVENT TOURISM THROUGH COMMUNITY ENGAGEMENT AND SUSTAINABLE PRACTICES. Management & Marketing, 23(1), 7. https://doi.org/10.52846/mnmk.23.1.01

Carvache-Franco, M., López, C. C., & Carvache-Franco, W. (2024). Market segmentation and consumer motivations in protected natural parks: A study from Spain. PLoS ONE, 19(1). https://doi.org/10.1371/journal.pone.0296199

Correia, A. M. S. S., & Pereira, Y. V. (2023). Empreendedorismo e catástrofes no turismo. Podium Sport Leisure and Tourism Review, 12(2), 335. https://doi.org/10.5585/podium.v12i2.22671

Delgado, F. J. G., Puche, A. M., & González, R. C. L. (2020). Heritage, Tourism and Local Development in Peripheral Rural Spaces: Mértola (Baixo Alentejo, Portugal). Preprints.Org. https://doi.org/10.20944/preprints202010.0002.v1

Demirdağ, İ., & Nirwansyah, A. W. (2024). Beyond disaster: investigating the varied responses of regional entrepreneurship to natural disasters. Natural Hazards, 120(11), 10413. https://doi.org/10.1007/s11069-024-06753-4

Diaz, M. G., & Santos, L. C. dos. (2025). Quarry mining or nature conservation, emerging conflicts in Serra de Aire e Candeeiros Natural Park (Portugal). Open Research Europe, 5, 348. https://doi.org/10.12688/openreseurope.19589.1

Engelhardt, R. A. (2008). Culturally and ecologically sustainable tourism development through local community management. In ANU Press eBooks. ANU Press. https://doi.org/10.22459/csdp.04.2005.13

Ferreira, C., Pinto, L. M. C., & Valente, M. (2024). Forest fire causes and prevention strategies in Portugal: Insights from stakeholder focus groups. Forest Policy and Economics, 169, 103330. https://doi.org/10.1016/j.forpol.2024.103330

Grammalidis, N., & Grammatikopoulou, A. (2024). Smart Participatory Methodologies for Sustainable Cultural Tourism in Rural Areas. In Springer proceedings in business and economics (p. 313). Springer International Publishing. https://doi.org/10.1007/978-3-031-51038-0_35

Guedes, A., & Jiménez, M. I. M. (2015). Spatial patterns of cultural tourism in Portugal. Tourism Management Perspectives, 16, 107. https://doi.org/10.1016/j.tmp.2015.07.010

Huang, Z., & Skidmore, M. (2023). The Impacts of Wildfires and Wildfire-induced Air Pollution on House Prices in the United States. Land Economics, 100(1), 22. https://doi.org/10.3368/le.100.1.102322-0093r

Iannucci, G., Martellozzo, F., & Randelli, F. (2022). Sustainable development of rural areas: a dynamic model in between tourism exploitation and landscape decline. Journal of Evolutionary Economics, 32(3), 991. https://doi.org/10.1007/s00191-022-00785-4

Ivona, A. (2021). Sustainability of Rural Tourism and Promotion of Local Development. Sustainability, 13(16), 8854. https://doi.org/10.3390/su13168854

Jansen-Verbeke, M. (2009). The territoriality paradigm in cultural tourism. Turyzm/Tourism, 19, 25. https://doi.org/10.2478/v10106-009-0003-z

Johansson, J. (2013). Sustainable Housing – The User Focus. Research Portal Denmark. https://local.forskningsportal.dk/local/dki-cgi/ws/cris-link?src=arkc&id=arkc-9720512c-9b34-4631-84af-ec7a732b70fd&ti=Sustainable%20Housing%20%2013%20The%20User%20Focus

Joshi, S., Panzer-Krause, S., Zerbe, S., & Saurwein, M. (2023). Rural tourism in Europe from a landscape perspective: A systematic review [Review of Rural tourism in Europe from a landscape perspective: A systematic review]. European Journal of Tourism Research, 36, 3616. Varna University of Management. https://doi.org/10.54055/ejtr.v36i.3328

Khodzhaeva, V. (2020). A Mobile Application As a Tool for Sustainable Development in Protected Areas (a proposal for the case of Arrabida Natural Park).

Kindling Change: Shaping a New Fire Culture in Mediterranean socioenvironmental systems from the roots. (2024). HUMAN GEOGRAPHIES – Journal of Studies and Research in Human Geography, 18(1). https://doi.org/10.5719/hgeo.2024.181.2

León, M. G.-U. G. de, Rieutort, L., Kamara, A., Santos, A. S., Pirra, A., & Solís, M. G. (2020). Demographic Challenges in Rural Europe and Cases of Resilience Based on Cultural Heritage Management. A Comparative Analysis in Mediterranean Countries Inner Regions. European Countryside, 12(3), 408. https://doi.org/10.2478/euco-2020-0022

Liu, W., Vogt, C. A., Luo, J., He, G., Frank, K. A., & Liu, J. (2012). Drivers and Socioeconomic Impacts of Tourism Participation in Protected Areas. PLoS ONE, 7(4). https://doi.org/10.1371/journal.pone.0035420

Lopes, V., Santos, L., & Santamaría, J. M. T. (2025). The Influence of Forest Fires on Ecological, Economic, and Social Trends in Landscape Dynamics in Portugal. Land, 14(6), 1273. https://doi.org/10.3390/land14061273

Magalhães, M. R., Cunha, N. lia, Pena, S., & Müller, A. (2021). FIRELAN | An Ecologically Based Planning Model Towards a Fire Resilient and Sustainable Landscape. A Case Study in Center Region of Portugal. Research Square (Research Square). https://doi.org/10.21203/rs.3.rs-412512/v1

Magalhães, M. R., Pena, S., Cunha, N. lia, Franco, L. M., & Müller, A. (2022). Transforming Rural Landscape towards Fire Resilience and Landscape

Sustainability. In Imprensa da Universidade de Coimbra eBooks (p. 422). https://doi.org/10.14195/978-989-26-2298-9_68

Meleddu, M., Pulina, M., Vannini, M., & Vecco, M. (2023). Assessing pro-environmental behaviors and implications for integrated conservation in protected areas: A study of visitors and entrepreneurs in the Asinara National Park, Italy. Environmental Economics, 14(2), 28. https://doi.org/10.21511/ee.14(2).2023.03

Moya, D. (2015). The use of remote sensing to assess forest fire resilience: A study case in SE Iberian Peninsula. CINECA IRIS Institutial Research Information System (University of Genoa). http://hdl.handle.net/11567/812901

Nie, X., Chawla, K., Irvin, D., Hirschberg, D., Wager, S., Wara, M. W., & Azevedo, I. M. L. (2023). Perception of Increasing Wildfire Risk Lowers Appreciation of Residential Real Estate in California. SSRN Electronic Journal. https://doi.org/10.2139/ssrn.4540783

Novikova, M., Ferreiro, M. de F., & Stryjakiewicz, T. (2020). Local Development Initiatives as Promoters of Social Innovation: Evidence from Two European Rural Regions. Quaestiones Geographicae, 39(2), 43. https://doi.org/10.2478/quageo-2020-0012

OECD. (2023). Taming wildfires in the context of climate change: The case of Portugal. In OECD environment policy papers. https://doi.org/10.1787/859bb47a-en

Otrachshenko, V., & Nunes, L. C. (2019). Fire Takes No Vacation: Impact of Fires on Tourism. Environment and Development Economics, 27(1), 86. https://doi.org/10.1017/s1355770x21000012

Palermo, A., Chieffallo, L., & Virgilio, S. (2023). The identification of cultural tourism geographies: Results from a Systematic Literature Review. Geographica Pannonica, 27(4), 254. https://doi.org/10.5937/gp27-46772

Preinfalk, E., & Handmer, J. (2024). Fueling the fires – An exploration of the drivers and the scope for management of European wildfire risk under the Shared Socioeconomic Pathways. Climate Risk Management, 45, 100638. https://doi.org/10.1016/j.crm.2024.100638

Primdahl, J., Eetvelde, V. V., & Pinto-Correia, T. (2020). Rural Landscapes—Challenges and Solutions to Landscape Governance. Land, 9(12), 521. https://doi.org/10.3390/land9120521

Putri, D. M., & Sayono, J. (2024). Economic Empowerment Model Based On Local Wisdom to Stretch Out Sustainable Development Goals In Padusan Village. In Advances in Social Science, Education and Humanities Research/Advances in social science, education and humanities research (p. 133). https://doi.org/10.2991/978-2-38476-228-6_12

Rasyid, Y. A. (2025). Leveraging Digital Transformation for Sustainable Rural Tourism in Indonesia. KnE Social Sciences, 10(29), 396. https://doi.org/10.18502/kss.v10i29.20282

Reiner, V., Pathirana, N. L., Sun, Y., Lenzen, M., & Malik, A. (2023). Wish You Were Here? the Economic Impact of the Tourism Shutdown from Australia's 2019-20

'Black Summer' Bushfires. Research Square (Research Square). https://doi.org/10.21203/rs.3.rs-3376778/v1

Rodrigues, A. M., Viegas, D. X., Zêzere, J. L., Santiago, A., & Laím, L. (2022). Rural fires – Causes of human losses in Portugal. In Imprensa da Universidade de Coimbra eBooks (p. 757). https://doi.org/10.14195/978-989-26-2298-9_116

Sansilvestri, R., Lucio, J. V. de, Seijo, F., & Zavala, M. Á. (2022). Can Neo-Rural Initiatives Bolster Community Resilience in Depopulated Coupled Human and Natural System?: Insights From Stakeholder Perceptions in Central Spain. Frontiers in Environmental Science, 10. https://doi.org/10.3389/fenvs.2022.869321

Santos, L., Lopes, V., & Baptista, C. (2022). MDIR Monthly Ignition Risk Maps, an Integrated Open-Source Strategy for Wildfire Prevention. Forests, 13(3), 408. https://doi.org/10.3390/f13030408

Santos, L., Stoica, I.-V., Cioclu, A., Toma, I.-A., & Zamfir, D. (2025). TOURISM IMPACT ON THE SUSTAINABLE DEVELOPMENT OF A MOUNTAIN REGION. Journal of Urban and Regional Analysis, 17(2). https://doi.org/10.37043/jura.2025.17.2.6

Santos, M., Rita, P., Moro, S., & Alturas, B. (2023). Electronic Word-of-Mouth and Tourist Satisfaction in Rural Tourism in Schist Villages. In Advances in hospitality, tourism and the services industry (AHTSI) book series (p. 88). IGI Global. https://doi.org/10.4018/978-1-6684-7242-2.ch004

Santos, R., & Castanho, R. A. (2024). Tourism and Sustainable Landscapes: A Portuguese Case. In IntechOpen eBooks. IntechOpen. https://doi.org/10.5772/intechopen.112690

Silva, F. R. da, Câmara, S. F., Pinto, F. R., Costa, F. J. da, Freitas, L. M. de, Júnior, J. G. C. de O., Paula, T. M. D., & Soares, M. de O. (2023). Machine learning application to assess deforestation and wildfire levels in protected areas with tourism management. Journal for Nature Conservation, 74, 126435. https://doi.org/10.1016/j.jnc.2023.126435

Silva, M. C., Bica, M. do C., & Soares, P. L. M. (2019). From the abandonment of small agriculture to the drama of rural fires. Journal of Historical Archaeology & Anthropological Sciences, 4(1), 1. https://doi.org/10.15406/jhaas.2019.04.00172

Silva, M. F., Do, M., Bica, C., & Soares, P. L. M. (2019). Journal of Historical Archaeology & Anthropological Sciences, 4(1). https://doi.org/10.15406/jhaas.4.1

Šušić, V., & Đorđević, D. (2019). Modern tendencies of international tourism development. Ekonomika, 65(2), 27. https://doi.org/10.5937/ekonomika1902027s

Tenreiro, R. N., & Martinho, V. J. P. D. (2024). Tourism in rural areas as a broader concept: Some insights from the Portuguese reality. Open Agriculture, 9(1). https://doi.org/10.1515/opag-2022-0345

Tonini, M., Parente, J., & Pereira, M. (2018). Global assessment of rural–urban interface in Portugal related to land cover changes. Natural Hazards and Earth System Sciences, 18(6), 1647. https://doi.org/10.5194/nhess-18-1647-2018

Tülek, B., & ALTUNTAŞ, A. (2021). Investigation of Tourism Interaction with Forest Fire Risk Areas in Cirali Region. Bartın Orman Fakültesi Dergisi, 23(1), 9. https://doi.org/10.24011/barofd.765332

Turtureanu, A. G., Creţu, C., Pripoaie, R., Marinescu, E. Ștefan, Sîrbu, C.-G., & Talaghir, L.-G. (2025). Sustainable Development Through Agritourism and Rural Tourism: Research Trends and Future Perspectives in the Pandemic and Post-Pandemic Period. Sustainability, 17(9), 3998. https://doi.org/10.3390/su17093998

Uyttewaal, K., Prat-Guitart, N., Ludwig, F., Kroeze, C., & Langer, E. R. (2023). Territories in Transition: how social contexts influence wildland fire adaptive capacity in rural Northwestern European Mediterranean areas. Fire Ecology, 19(1). https://doi.org/10.1186/s42408-023-00168-5

Viegas, M., Batista, P., & Cordovil, F. (2022). The Portuguese Forest and the Common Agricultural Policy. Research Square (Research Square). https://doi.org/10.21203/rs.3.rs-2292352/v1

Vinodan, A., & Meera, S. (2024). Exploring the Role of Non-Formal Education in Tourism Resource Management. Australian Journal of Environmental Education, 40(4), 662. https://doi.org/10.1017/aee.2024.11

Vogklis, K. (2025). Leveraging spatiotemporal big data for sustainable destination development: an interdisciplinary approach. Information Technology & Tourism, 27(4), 981. https://doi.org/10.1007/s40558-025-00338-y

Wang, J., Dai, J., Gao, W., Yao, X., Dewancker, B., Gao, J., Wang, Y., & Zeng, J. (2024). Achieving Sustainable Tourism: Analysis of the Impact of Environmental Education on Tourists' Responsible Behavior. Sustainability, 16(2), 552. https://doi.org/10.3390/su16020552

Wilkins, E. J., & Horne, L. (2024). Effects and perceptions of weather, climate, and climate change on outdoor recreation and nature-based tourism in the United States: A systematic review [Review of Effects and perceptions of weather, climate, and climate change on outdoor recreation and nature-based tourism in the United States: A systematic review]. PLOS Climate, 3(4). Public Library of Science. https://doi.org/10.1371/journal.pclm.0000266